Q. What is the circumference of the earth? I mean, how many miles is it round?

A. 25,058 miles.

Q. Was it ever failed round?

A. Frequently; firſt by Magellan a Spaniard; afterwards by Sir Francis Drake, our own countryman; and, in later times by Commodore Byron, Captains Cook, Furneaux, Carteret, Wallis, and others.

Q. What diſcoveries did theſe circumnavigators make?

A. The two firſt made very few; but the laſt have found that the great South-ſea, in certain latitudes, is covered with an infinite number of iſlands, and one of them in particular, called New South Wales, ſo large, that it almoſt deſerves the name of a continent.

Q. I think I have heard of a remarkable circumſtance that occurs according as a ſhip directs her courſe eaſt or weſt in ſailing round the world. Is there not ſuch a one?

A. There certainly is, and it is this. If a ſhip ſets out from any port, and ſails round the earth eaſtward to the ſame port again, let her take what time ſhe will to do it in, the people in that ſhip, in reckoning their time, will gain one complete day at their return, or count one day more

than

than thofe who refide at the fame port; becauſe by going contrary to the ſun's diurnal motion, and being forwarder every evening than they were in the morning, their horizon will get ſo much the ſooner above the ſetting ſun than if they had kept for a whole day at any particular place. And thus, by cutting off a part proportionable to their own motion, from the length of every day, they will gain a complete day of that ſort at their return; without gaining one moment of abſolute time more than is elapſed, during their courſe, to the people at the port.

If, on the other hand, they ſail weſtward, they will reckon one day leſs than the people do who refide at the ſaid port, becauſe by gradually following the apparent diurnal motion of the ſun, they will keep him each particular day ſo much longer above the horizon, as anſwers to that day's courſe; and, by that means, they cnt off a whole day in reckoning, at their return, without loſing one moment of abſolute time.

Hence, if two ſhips ſhould ſet out at the ſame time from any port, and ſail round the globe, one eaſtward and the other weſtward, ſo as to meet at the ſame port on any day whatever, they will differ two days in reckoning their time, at their return. If they ſail twice round the earth, they

will

will differ four days; if they fail thrice, they will differ fix days; if four times, eight days, &c.

OF THE WIND.

Q. I ſhould like to have a more particular account of the wind than any I have yet received: will you be pleaſed to give it me?

A. I will endeavour to do ſo.

Q. I ſhall be much obliged to you.

A. You know then, as I formerly told you, that wind is chiefly occaſioned by a rarefaction of the air; for when the air is rarefied, it naturally aſcends into the higher regions; and the circumjacent air, which is thicker and heavier, immediately ruſhes in to ſupply its place, and fill up the vacancy. This motion of the air we call wind, and we give it the name of a breeze, a gale, or ſtorm, according to the quickneſs or velocity of its motion.

Q. All this I perfectly underſtand, and very well remember. But I wiſh you would be a little more particular. Are there not certain winds, called tropical winds, which blow almoſt always from the ſame point of the compaſs?

A. There

A. There are, and they are of three kinds.

1. The *general trade winds*, which extend to near thirty degrees of latitude on each ſide of the equator, in the Atlantic, Ethiopic, and Pacific oceans. On the north ſide of the equator, they blow from north-eaſt, on the ſouth ſide from ſouth-eaſt, and near the equator from almoſt due eaſt.

2. The *monſoons*, or ſhifting trade winds, which blow ſix months in one direction, and the other ſix months in an oppoſite direction. Theſe are moſtly in the Indian or Eaſtern ocean, and do not reach above two hundred leagues from the land. Their change is at the vernal and autumnal equinox, and it is accompanied with terrible ſtorms of thunder, lightning, and rain.

3. *The land and ſea breezes*, which are periodical winds, and blow from the land from night to about mid-day, and from the ſea from about noon to mid-night. Theſe winds do not extend above two or three leagues from the ſhore.

Beyond the latitude of thirty degrees, north and ſouth, the winds, as we daily perceive in Great Britain, are more variable, though it may be obſerved in general, that the tendency of the wind is from a colder region to that which is hotter.

OF

OF THE TIDES.

Q. What have you to obſerve of the tides beſides what you formerly mentioned?

A. It muſt firſt be obſerved, that the ſun attracts the earth, as well as the moon does; but he attracts it, however, with much leſs force, on account of his infinitely greater diſtance.

Q. When have we the higheſt tides?

A. At the new and full moon, and the tides then are called ſpring tides; for at theſe times the actions both of the ſun and moon are united, and draw in the ſame ſtraight line, and conſequently the ſea muſt be more elevated. At the conjunction, that is, the new moon, when the ſun and moon are on the ſame ſide of the earth, they both conſpire to raiſe the waters in the zenith, and conſequently in the nadir; and at the oppoſition, or full moon, when the earth is between the ſun and moon, while one occaſions high water in the zenith and nadir, the other does the ſame.

Q. When do the loweſt tides happen?

A. The loweſt tides, or (as they are uſually called) the neap tides, happen about the firſt and laſt quarters of the moon; for then the influence

of

of the ſun and moon counteract each other: the ſun raiſes the waters where the moon depreſſes them, and depreſſes where the moon raiſes them; ſo that the tides are only occaſioned by the difference, by which the action of the moon, which is neareſt us, prevails over that of the ſun.

Q. Do theſe things happen regularly?

A. They would do ſo, were the whole ſurface of the earth covered with water, but as there is a multitude of iſlands and continents, which interrupt the natural courſe of the water, a variety of appearances are to be met with in different places, which cannot be explained without regarding the ſituation of ſhores, ſtraits, and other objects, which have a ſhare in producing them.

Q. Are there not various currents in the ſea?

A. Yes; there is a current between Florida and the Bahama iſlands, which always runs from north to ſouth. A current runs conſtantly from the Atlantic, through the ſtraits of Gibraltar into the Mediterranean. A current ſets out of the Baltic ſea, through the Sound or ſtrait between Sweden and Denmark, in the Britiſh ocean, ſo that there are no tides in the Baltic.

Q. But if a current conſtantly runs from the Atlantic into the Mediterranean, is it not ſtrange that the waters of the ſea do not increaſe?

A. No;

A. No: the water extracted from it in vapours is more than ſufficient to counterbalance the influx.

Q. How does this appear?

A. It has been found by calculation, that in a ſummer's day, there may be raiſed, in vapours, from the Mediterranean 5280 millions of tons of water, yet this ſea receives not from all its nine great rivers above 1827 millions of tons per day, which is but one third of what is exhauſted in vapours; ſo that, were it not for the influx from the Atlantic, the Mediterranean would ſoon be rendered dry.

Q. How high do the tides ever riſe?

A. About ſmall iſlands, and the headlands in the middle of the ocean, the tides riſe very little; but in ſome bays, and about the mouths of rivers, they riſe from 12 to 50 feet.

Q. Are the tides always higheſt preciſely at the time of the new and full moons?

A. No; they are generally higheſt about three tides after.

Q. Are the ſame tides (viz. ſpring and neap) of the ſame height in the ſame place all the year round?

A. No; for as I have already ſaid, the earth is ſomewhat nearer the ſun in winter than it is in ſummer; and therefore the greateſt equinoctial

tides

tides are obſerved to happen ſome time before the vernal equinox, and a little after the autumnal one.

ELECTRICITY.

Q. Whence comes the word electricity?

A. From the Greek word ηλεκτρον, ſignifying amber, which was the firſt ſubſtance that was obſerved to have the property of attracting ſtraws and other light bodies; for this was the ſimple origin of a ſcience that is now arrived at very great perfection.

Q. Is not the word electricity commonly taken in a more extended ſenſe?

A. It is commonly underſtood to mean the electrical matter, or the art of putting that matter in motion, or calling it into motion.

Q. What is the electrical matter?

A. It is a ſubtile fire that pervades all nature, and produces the moſt ſurprizing effects.

Q. What are the principal of theſe effects?

A. Thunder and lightning is undoubtedly one of them; earthquakes are probably, at leaſt in ſome

ſome meaſure, another; and it is even ſuppoſed by ſome philoſophers, that the *Aurora Borealis*, or northern lights, are owing to the ſame cauſe.

Q. How does it appear, that thunder and lightning are owing to electricity?

A. Dr. Franklin has proved, by a variety of experiments, that the lightning of electricity and the lightning that flaſhes from the clouds in a thunder ſtorm, are exactly of the ſame kind, and operate in the ſame manner.

Q. I ſhould be glad to hear the particular points, in which theſe two kinds of lightning agree, and produce the ſame or ſimilar effects.

A. You are right in ſaying ſimilar; for though they are certainly the ſame in kind, they are not always the ſame in degree: the works of men can never equal the operations of nature.

Q. In what reſpects, then, do they agree?

A. I ſhall inform you almoſt in the doctor's own words; after obſerving, that electricians have the art of making a machine, by which they can draw fire from a variety of bodies, and even accumulate, or heap it together in ſuch quantities, that when it is diſcharged, or let off, it will make a report like a piſtol, and even kill animals.

Q. I ſhould like to ſee ſuch a machine?

A. You may ſee it at the ſhop of any maker of

of mathematical inſtruments, and ſuch are to be found in every capital town in the kingdom. But to deſcribe to you a machine, which you could not make, would be not only dry and unintereſting, but almoſt unintelligible. You muſt, therefore, at preſent, take the thing for granted.

Q. Very well; proceed, if you pleaſe, with the particulars, in which theſe two kinds of lightning agree.

A. Here, then, they follow:

1. Flaſhes of lightning, ſays the doctor, are generally ſeen crooked, and waving in the air. The ſame, adds he, is the electric ſpark always, when it is drawn from an irregular body at ſome diſtance.

2. Lightning ſtrikes the higheſt and moſt pointed objects in its way preferable to others, as high hills and trees, towers, ſpires, maſts of ſhips, points of ſpears, &c. In like manner, all pointed conductors* receive or throw off the electric fluid more readily than thoſe that are terminated by flat ſurfaces.

* Conductor is a term uſed by electricians for denoting any thing that conducts the electric fire from one body to another.

3. Lightning is obſerved to take the readieſt and beſt conductor. So does electricity in the diſcharge of the Leyden phial.*

For this reaſon the doctor ſuppoſes, that it would be ſafer, during a thunder ſtorm, to have one's cloaths wet than dry, as the lightning might then, in a great meaſure, be tranſmitted to the ground, by the water on the outſide of the body. It is found, he ſays, that a wet rat cannot be killed by the exploſion of the electrical bottle, but that a dry rat may.

4. Lightning burns: ſo does electricity. Dr. Franklin ſays, that he could kindle with it hard dry roſin, ſpirits unwarmed, and even wood.

5. Lightning ſometimes diſſolves metals: ſo does electricity.

6. Lightning rends ſome bodies: the ſame does electricity. Dr. Franklin obſerves, that the electric ſpark would ſtrike a hole through a quire of paper.

7. Lightning has often been known to ſtrike people blind. And a pigeon after a violent ſhock of electricity, by which the doctor intended to

* A glaſs that contains an accumulation of electric matter.

have

have killed it, was obſerved to have been ſtruck blind likewiſe.

8. Lightning deſtroys animal life. Animals have likewiſe been killed by the ſhock of electricity. The largeſt animals, which Dr. Franklin and his friends had been able to kill, were a hen, and a turkey which weighed about ten pounds.

To demonſtrate, in the cleareſt manner poſſible, the famenefs of electrical fire with the matter of lightning, Dr. Franklin, aſtoniſhing as it muſt have appeared, contrived actually to bring lightning from the heavens, by means of an electrical kite, which he raiſed when a ſtorm of thunder was perceived to be coming on.

This kite had a pointed wire fixed upon it, by which it drew the lightning from the clouds. The lightning deſcended along the hempen ſtring that held the kite, and was received by a key tied to the extremity of it; that part of the ſtring which the doctor had in hand, being of ſilk,* that the electric fire might ſtop at the key, and not reach his body.

He found, that the ſtring would conduct electricity even when nearly dry, but that, when it

* Some bodies conduct the electric fire, and ſome do not conduct it. Silk is of the latter kind.

was wet, it would conduct it quite freely; ſo that it would ſtream out plentifully from the key, at the approach of a perſon's finger.

At this key he charged phials, and from electric fire thus obtained, he kindled ſpirits, and performed all the common electrical experiments.

Q. Was not this diſcovery, of the ſameneſs of lightning and electricity, applied by Dr. Franklin to a moſt uſeful purpoſe?

A. It certainly was, namely, to the ſecuring buildings from the dreadful effects of lightning in a thunder ſtorm; for as to the thunder itſelf, or the ſound or noiſe we hear, it is perfectly harmleſs; it is the lightning alone that does the miſchief.

Q. How did he effect this?

A. Only by fixing a pointed iron rod higher than any part of the building, and joining to the lower end of it a wire, which communicated with the earth, or rather the neareſt water. This rod the lightning was ſure to ſeize upon preferable to any other part of the building, and deſcended along it and the wire till it reached the earth, where it was inſtantly diſſipated, without doing any harm.

Q. Ought not all public buildings, and eſpecially all magazines, to have ſuch an apparatus for defending them from lightning?

A. They

A. They certainly ought, and many, I believe, have.

Q. Does lightning do great miſchief in this cold climate of England?

A. Not frequently; yet ſuch a thing ſometimes happens, as was the caſe with St. Bride's church, in London, the ſteeple of which was damaged by a thunder ſtorm in 1764.

Q. Is not the fire of electricity very different from common fire?

A. It is, and operates in a very different manner. It has been known to melt a ſword in the ſcabbard without injuring the ſcabbard itſelf; and to melt money in a man's pocket without burning his cloaths. In a word, it ſeems to be of ſuch a nature, that it can eaſily penetrate through porous bodies without affecting them, and ſpends all its force upon thoſe that are hard and ſolid.

Q. May not the experiment of drawing lightning from heaven, by means of an electric kite, be attended with danger?

A. It no doubt may, and even actually has. It proved fatal to Abbé Richman, who, in 1753, was killed by a flaſh of lightning he drew down from the clouds, in an experiment he was making at Peterſburgh.

Q. Has not electricity been applied to ſome medical purpoſes?

A. It has, and that too, it is ſaid, with ſo much ſucceſs, that it may now be conſidered as part of the ſcience. We believe, however, that thoſe who adminiſter it, are rather looked upon by the reſt of the faculty as ſo many quacks, as indeed the exhibiters of all new medicines are till their authority is firmly eſtabliſhed.

Q. May not ſome electrical experiments be performed without the help of an electrical machine?

A. Yes, ſuch as ſhew the attractive and repulſive power of bodies, but not ſuch as produce lightning. Here follows one. Cut two bits of cork into the ſhape and ſize of a common pea. With a needle draw a thread through each of the corks, ſo that they may hang at the ends of the threads with a knot below them. Let the other ends of the threads be inſerted in the notch of a ſmall piece of wood, about a foot long, an inch broad, and of the thickneſs of a common match. Lay the piece of wood over the mouths of two wine glaſſes a few inches aſunder, ſo that the end of it, in which the threads are, may project over the edge of the hither glaſs, and the corks may be in contact with one another. Take another wine glaſs, and having rubbed it heartily with a piece

of

of flannel, or the ſkirt of a woollen coat, hold its mouth to within about an inch of the corks, and you will ſee them ſuddenly ſtart and continue aſunder for a conſiderable time.

Q. How does it appear that electricity has any ſhare in producing earthquakes?

A. This has been already explained in page 22.

Q. You ſaid, that in the opinion of ſome philoſophers, the *Aurora Borealis*, or Northern Lights, are owing to electricity. Who are the philoſophers that entertain this opinion?

A. Signior Beccaria, of Turin, was the firſt that advanced it. He thinks that the *aurora borealis* may be the electric matter performing its circulation in ſuch a ſtate of the atmoſphere as renders it viſible, or approaching nearer to the earth than uſual.

He was followed in the ſame ſentiments by Mr. Canton, our countryman, who ſays, that the *aurora borealis* may be the flaſhing of electric fire from poſitive towards negative clouds,* at a great diſtance, through the upper part of the atmoſphere, where the reſiſtance is leaſt. He ſuppoſes, that the *aurora borealis*, which happens at the time

* Clouds are ſaid to be poſitive when they have too much electricity, and negative when they have too little.

that

that the needle (in the mariner's compaſs) is diſturbed by the heat of the earth, is the electricity of the heated air above; and this, he ſays, will appear chiefly in the northern regions, as the alteration in the heat of the air in thoſe parts will be the greateſt.

This hypotheſis, he adds, will not ſeem improbable, if it be conſidered, that electricity is now known to be the cauſe of thunder and lightning; that it has been extracted from the air at the time of an *aurora borealis*; that the inhabitants of the northern countries obſerve the aurora to be remarkably ſtrong, when a ſudden heat happens after ſevere cold weather; and that the curious in theſe matters are now acquainted with a ſubſtance that will, without friction, both emit and abſorb the electric fluid, only by the increaſe or diminution of its heat: meaning the Tourmalin, a ſingular kind of ſtone, the properties of which were about this time diſcovered.

Q. Is not electricity ſuppoſed to be the cauſe of many other phænomena beſides thoſe you have mentioned?

A. Signior Beccaria thinks it is the cauſe of *water ſpouts*. To make this the more evident, he firſt deſcribes the circumſtances attending the appearance of theſe ſpouts. They are as follow.

They

They generally appear in calm weather. The ſea ſeems to boil, and ſend up a ſmoke under them, riſing into a hill towards the ſpout. At the ſame time, perſons who have been near them have heard a rumbling noiſe. The ſhape of a water ſpout is that of a ſpeaking trumpet, the wider end being in the clouds, and the narrower end towards the ſea.

The ſize is various even in the ſame ſpout.—The colour is ſometimes inclining to white, and ſometimes to black. Their poſition is ſometimes perpendicular to the ſea, ſometimes oblique, and ſometimes the ſpout itſelf is in the form of a curve. Their continuance is very various, ſome diſappearing as ſoon as formed, and ſome continuing a conſiderable time. One that he had heard of continued a whole hour. But they often vaniſh, and preſently appear again in the ſame place.

Q. Does not Beccaria likewiſe ſuppoſe, that whirlwinds and hurricanes are owing to electricity?

A. He does, and adds, that what water ſpouts are at ſea, whirlwinds and hurricanes are by land. They have been known to tear up trees, to throw down buildings, make caverns in the earth; and in all theſe caſes, to ſcatter earth, ſtones, bricks, timber, &c. to a great diſtance in every direction. Great quantities of water have been left, or raiſed

by

by them, ſo as to make a kind of deluge; and they have always been attended with a prodigious rumbling noiſe.

That theſe phænomena depend upon electricity, cannot, he ſays, but appear very probable from the nature of ſeveral of them; but the conjecture is made more probable from the following additional circumſtances.

They generally appear in months peculiarly ſubject to thunder ſtorms, and are co monly preceded, accompanied or followed by lightning, rain, or hail. Whitiſh or yellowiſh flaſhes of light have ſometimes been ſeen moving with prodigious ſwiftneſs about them. And, laſtly, the manner in which they terminate exactly reſembles what might be expected from the prolongation of an electrified cloud towards the ſea; the water and the cloud mutually attracting one another: for they ſuddenly contract themſelves, and diſperſe almoſt at once; the cloud riſing, and the water of the ſea under it falling to its level.

But the moſt remarkable circumſtance, and the moſt favourable to the ſuppoſition of their depending upon electricity, is, that they have been diſperſed by preſenting to them ſharp-pointed knives or ſwords. This, at leaſt, is the conſtant practice of mariners, in many parts of the world where theſe

water

water ſpouts abound; and he was aſſured, he ſays, by ſeveral of them, that this method has often been attended with ſucceſs.

Q. I think I have heard it ſaid, that the meteor we uſually call a falling ſtar, is an electrical appearance: is it ſo?

A. It probably is, and the fact, which Signior Beccaria mentions in confirmation of this opinion, is very curious and remarkable.

As he was one time ſitting with a friend in the open air, an hour after ſun-ſet, they ſaw what is called a falling ſtar directing its courſe towards them, and apparently growing larger and larger, till it diſappeared not far from them; when it left their faces, hands, and cloaths, with the earth, and all the neighbouring objects, ſuddenly illuminated with a diffuſed and gentle light, attended with no noiſe at all.

While they were ſtarting up, ſtanding, and looking at one another, ſurpriſed at the appearance, a ſervant came running to them out of a neighbouringgarden, and aſked them if they had ſeen nothing; for that he had ſeen a light ſhine ſuddenly in the garden, and eſpecially upon the ſtreams which he was throwing to water it.

FINIS.

DIRECTIONS TO THE BINDER

FOR

PLACING THE CUTS.